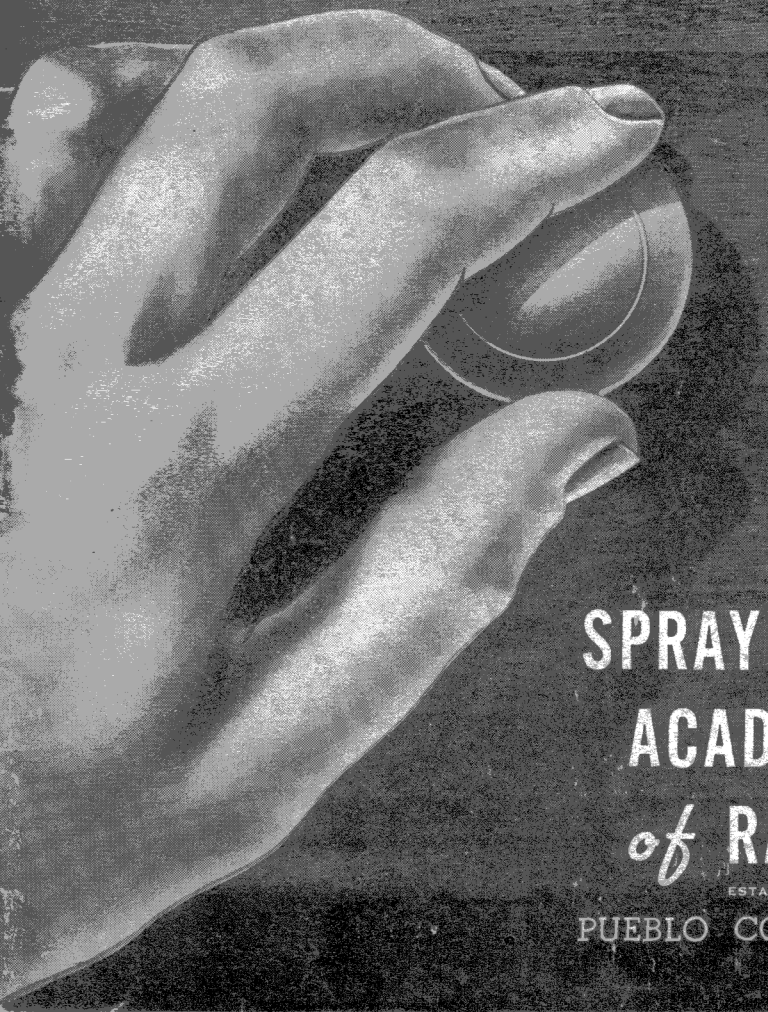
RECTIFIER TUBES

TUBE STANDARDS AND RATINGS

LESSON ND 12



SPRAYBERRY ACADEMY of RADIO

ESTABLISHED 1932

PUEBLO COLORADO

RECTIFIER TUBES

TUBE STANDARDS AND RATINGS

Lesson ND-12—Part 1

The first part of this lesson continues the description of rectifier type tubes. The second section, beginning on page 10, is devoted to tube standards and ratings. So please refer to the end of lesson ND-11 if the meaning below is not clear.

A circuit showing this connection is given in Fig. 26. A condenser C1 is placed across the speaker field so as to maintain the voltage across it constant. Choke L2 is the filter choke and R represents the receiver load. In this arrangement, the speaker field coil acts just like any other iron core filter choke. Later lessons will take up the details of speakers, and give adequate treatment to field coils, etc.

Mercury Vapor Rectifiers

Although not nearly as popular now as at one stage in radio receiver development, the mercury vapor tube is still widely used. It is important for you to be familiar with it, because it still has considerable application in radio receivers. The small full wave types for receiver use are the 82 and 83.

This type of tube is structurally very similar to the high vacuum types you have studied. Instead of a high vacuum, mercury vapor tubes contain a very small amount of mercury vapor. These tubes are of the filament type, having no separate cathode. The filament has a metalic oxide coating similar to many of the high vacuum types.

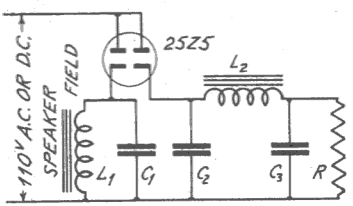


FIG. 26

The operation of the mercury vapor tube is somewhat different from that of the high vacuum types. Note in Fig. 12A that just as soon as the plate becomes positive with respect to the cathode some plate current flows. As the plate voltage rises, the plate to filament voltage also rises, gradually from zero to about 75 volts—the amount of the internal voltage tube drop. Unlike the high vacuum type, the mercury vapor tube will carry *absolutely no plate current until a certain critical voltage is reached*. This voltage is between 20 and 25 volts. When this amount of voltage is impressed from plate to cathode, the mercury vapor inside the tube will suddenly become ionized—that is, many of the mercury atoms will give up their electrons and the space between the plate and filament of the rectifier will become *highly conductive*. As long as this *internal tube drop* voltage is maintained above approximately 15 volts, the ionization of the mercury vapor will be maintained and electrons will be able to flow *very freely* from the hot filament to the plate. Once the mercury vapor has become ionized, the current flowing through the vapor will maintain ionization at the lower value of 15 volts.

Moreover, as the plate current increases with a rise in the supply voltage, the tube drop does not increase as is the case with the high vacuum

types but remains at 15 volts. It remains at this value regardless of how much current the plate carries up to the point where the tube will be destroyed by overheating. This means that you will never find the plate more than 15 volts positive (except when starting at 20 or 25 volts) with respect to the filament.

Figure 27 shows the usual full-wave rectifier circuit and Fig. 27A shows the wave analysis as in the former cases. Note from the curves of Fig. 27A, that the applied plate voltage for either plate A or D never is more than 15 volts more positive than the cathode—the voltage of the latter is shown by curve C in Fig. 27A. During a small length of time

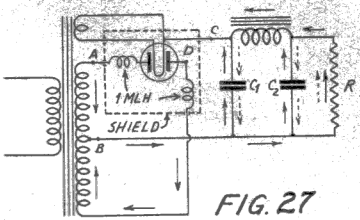


FIG. 27

(T0 to T1), the rectifier carries no current at all. Then suddenly as the plate voltage of the A plate rises to 20 or 25 volts, the current starts. It rises almost instantly to maximum current that the load will carry. From T1 on to time T2 the cathode remains only 15 volts below the plate voltage and the current rapidly rises to a maximum and falls to a lower value as the condenser reaches full

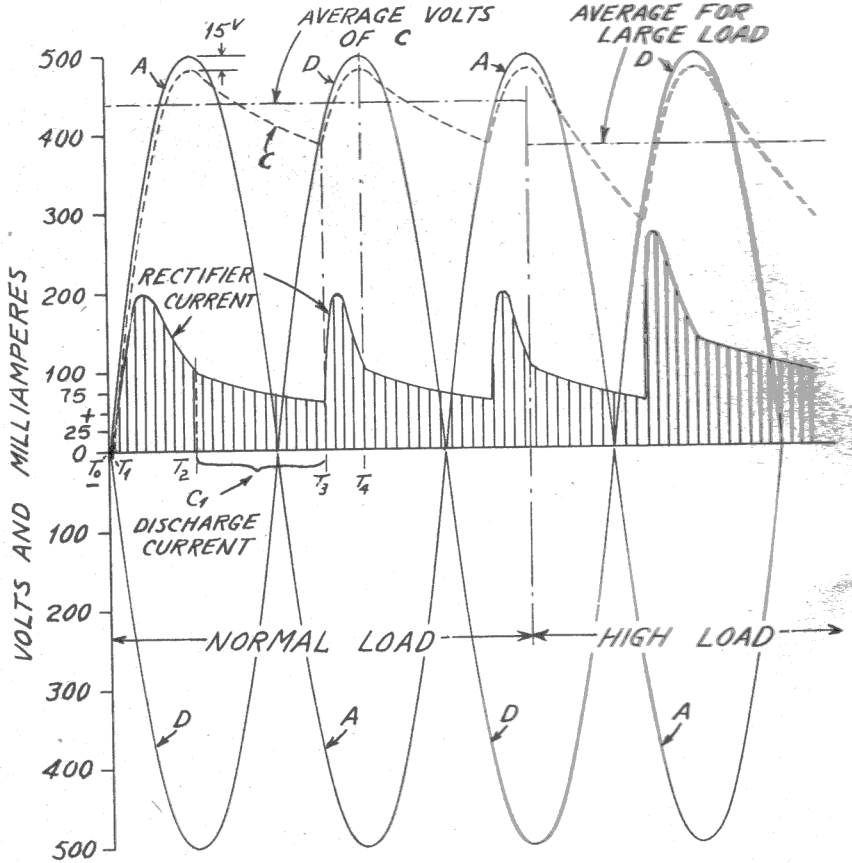


FIG. 27A

charge. Then just beyond time T2 as the plate voltage of A falls a trifle while the cathode voltage is held up by the charge of C1, the current carried through the tube suddenly stops. After the rectifier operates for a few cycles, the condition at time T3 to T4 is obtained, where the tube current suddenly starts at T3 and suddenly stops at T4. This is the time during which the tube is ionized, and note that it is just about one-eighth of a cycle or less. During this time when the tube carries current it produces a rather intense bluish glow. *This is the normal action for this type of tube,* but for a high vacuum tube it would indicate that the tube was definitely defective or that it was heavily overloaded — caused by a short circuit.

When the load on the mercury vapor rectifier is increased the voltage between the plate and cathode is not increased at all, the tube internal voltage drop remains the same, namely, 15 volts. The average input voltage to the filter is reduced because of the effect of the filter and this effect is not due to the tube.

In Fig. 27 will be noticed an R. F. choke coil in series with each plate lead and a shield (denoted by dotted lines) surrounding the tube and the choke coils. Either the choke coils or the shield, or both, should be used with the mercury vapor tube in any set of reasonably high sensitivity. When a current is very abruptly started or stopped in any circuit, magnetic radiation will result. This type of rectifier tube causes the current in the rectifier circuit to abruptly start and stop as illustrated in Fig. 27A, and this causes magnetic radiation or radio interference. The choke coils are for the purpose of more gradually *damping out* (allowing to reduce) the current more slowly in the circuit. The shield absorbs the radiated energy resulting from this action of the tube, and for best results, both the shield and choke coils should be used.

For the high vacuum rectifier tube there is a definite limit to the amount of voltage that can be applied across the plate and filament or cathode. Because of the constant 15 volt internal tube drop (voltage from plate to filament) of the mercury vapor tube the plate voltage applied or the plate current flowing are not limited for the same reasons. For example, if the internal tube drop of a high vacuum tube is doubled, its resistance actually reduces and it draws more than twice the current that it did before. This means that the power which it is using is increased more than 4 times. At 50 volts drop and 50 ma. current flow, it will be using only 50×.05 or 2.5 watts, while at 100 volts drop, it may carry 120 ma. using a power of 100×.12 or 12 watts. Being in effect a pure resistance, the plate of the rectifier tube converts all of this power into heat.

Now for a mercury vapor tube, by drawing twice the current through it at 15 volts drop, we have first: 15×.05 or .75 watt for 50 ma. load current and 15×.12 or 1.8 watts for 120 ma. load current. It is immediately apparent that the mercury vapor tube is much more efficient from this view point.

If the applied plate to ground voltage is excessive for a mercury vapor rectifier, there will be a large voltage across the plate which is at a negative peak and the cathode which is almost at a positive peak. In a high vacuum tube this would not be quite so harmful because there is no ionization or, if there is any, due to gas traces, it is negligible. On the other hand, in a mercury vapor rectifier, excessive voltage even in the reverse direction or *inverse* to the normal rectifier direction, will cause ionization and will often completely destroy the tube.

For this reason, it is more suitable to specify the tube's operation in terms of the maximum allowable

inverse voltage which it can stand without breaking down. This is called the *peak inverse voltage.*

At time T2 in Fig. 27A when plate D of Fig. 27 is at a negative peak (minus 500 volts) and the cathode is at 485 volts (15 volts below the plate voltage of the other plate), the inverse peak voltage would be 500+485 or 985 volts. If the tube is rated above this figure it is quite suitable for this use.

Power equipment using mercury vapor tubes is used principally for radio receivers and public address amplifiers where a large power output is required. The mercury vapor tube is especially suited to types of amplifiers which produce large current load changes such as *class B* amplifiers which you will study later on.

Parallel Operated Rectifiers

Where two or more rectifier tubes are used in parallel in any circuit for any type of tube, each plate should have a small resistance in series with it. While this is not always done in the case of high vacuum tubes, it is essential for mercury vapor tubes. For a full wave rectifier, using two full wave tubes, there are two common ways of making connections. In Fig. 28A one plate of each tube is wired

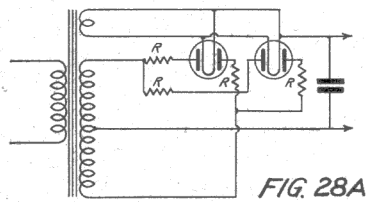
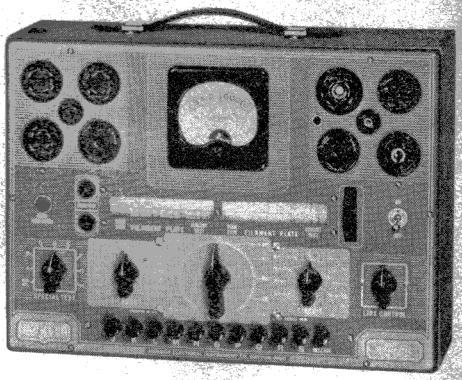


FIG. 28A

to each side of the high voltage winding with 50 to 100 ohms resistance for R in each plate lead. Any number of tubes may be connected in this way—as many as 3 are used in some broadcast receivers. Another method is shown in Fig. 28B where both plates of one tube are connected to one side of the high voltage winding.

In addition to the value of the resistors as described in connection



The above shows a typical manufactured tube tester. It has a roll type tube chart which gives directions for setting the various controls for different type tubes. The meter scale reads in terms of GOOD OR BAD with reference to the tube's condition. *Courtesy of Jackson Electrical Instrument Co.*

with Figs. 24 and 25, there is another reason for their use here. The resistors will tend to equalize the loads on all of the plates. If they are not used, any tendence for one plate to draw more current than the other will be increased if the plates are directly connected whereas the resistors will prevent this tendency.

Rectifier Filament Acts as a Common Circuit for A.C. and D.C.

Your study of rectifiers is not complete without considering the filament or cathode circuit with respect to its potentials. In Fig. 29 is shown the centertap high voltage D.C. connection at A, and the more popular side connection at B. This connection establishes the positive D.C. output terminal for the rectifier tube. In Fig. 29A there is a fairly steady flow of rectified direct current in the center of the filament winding. Starting with the beginning of the A.C. cycle of the filament, during the time that

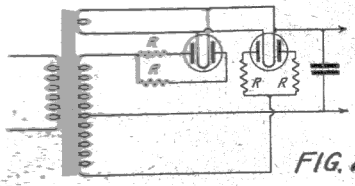


FIG. 28B

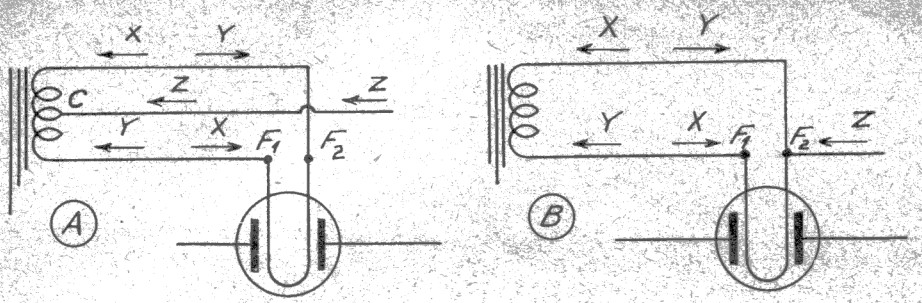


FIG. 29

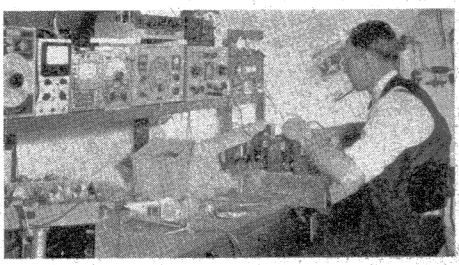
the filament voltage is passing through zero, the rectified plate current flows from the center toward each end of the winding and from each end to the filament terminals F2 and F1. As F2 rises in the positive direction with respect to the center terminal C, F1 will rise in the negative direction to the same amount. As soon as the filament voltage is sufficient to drive a current in the filament equal to the plate current, the plate current flow from the winding towards F1 ceases. This occurs when filament current in the direction Y is equal to the incoming plate current Z. From this time on, all of the plate current flows into the F2 filament terminal. The plate current is always a very small percentage of the filament current usually from 3 to 10% so that it will not materially affect the operation of the filament. For example, the 80-tube filament carries 2 amperes and with maximum plate current of 110 ma. or .11 amp. Note this will add less than 6% to the filament current. Note also the filament is acting as a *common circuit* for the filament current and also the plate current. This is permissible as long as the total current does not exceed the current carrying limit of the filament.

For the other half cycle the filament current flows in the direction X and the rectified plate current flows toward F1, rather than F2. A similar situation exists when the side connection of the filament is employed. In the circuit of Fig. 29B, when the filament current is flowing in the direction Y, the rectified plate current simply adds to it at F2 and enters the filament at this point. When the filament current is flowing in the direction X, the rectified plate current from F2 flows around through the filament winding and into the filament of the tube at F1.

The filament wire or winding, of course, cannot distinguish which is plate current or which is filament current and so out of a total current flowing the plates draw what is demanded by the load and supply voltage. The filament and entire filament winding and connections remain at a fairly high positive voltage and hence plate current is drawn from all portions of the heated filament.

The Cold Cathode Rectifier

Since the beginning of the development of tubes attempts have been made to eliminate the heater—that is, to operate the cathode without the

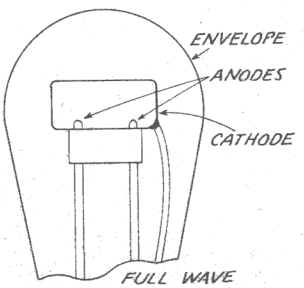


Every radio man sooner or later has his own pet work bench arranged just to suit him. The above photo shows a typical work bench with test instruments arranged for quick testing. Many of the popular radio magazines publish complete construction plans for radio work benches from time to time.

necessity of heating. This was done with varying degrees of success almost at the beginning of tube developments. Such tubes as the BA, BH and BR were in use as early as 1927. Others date back to 1920. These developments have led to the wide application of the OZ4 and OZ4G tubes as *cold cathode* rectifiers. The OZ4 is a metal tube, while the OZ4G is its glass equivalent.

The anodes, of which there are two, consist of very small projecting ends of graphite, approximately having the composition and appearance of small pencil leads. Only the ends of these anodes protrude from a nickel shield into the active part of the tube. These anodes are adequately separated by about ½ inch or more. The single cathode consists of a number of thin platinum ribbons coated with oxide of barium or stronium. The *total area of the cathode is many times larger than that of the anodes.* The tube is evacuated and then a small amount of *argon gas* is admitted. This gas is used because of its low ionization potential. Neon gas could be used almost as effectively. The mechanical arrangement of a tube of this basic action is shown in Fig. 30. In this case, the cathode is a large plate of tantalum, nickel or tungsten.

Now when a voltage is impressed between the anode and cathode tending to make the anode positive, it must be increased to about 300 volts



COLD CATHODE FULL WAVE GAS RECTIFIER

FIG. 30

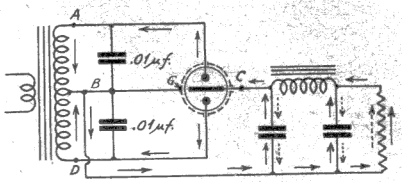
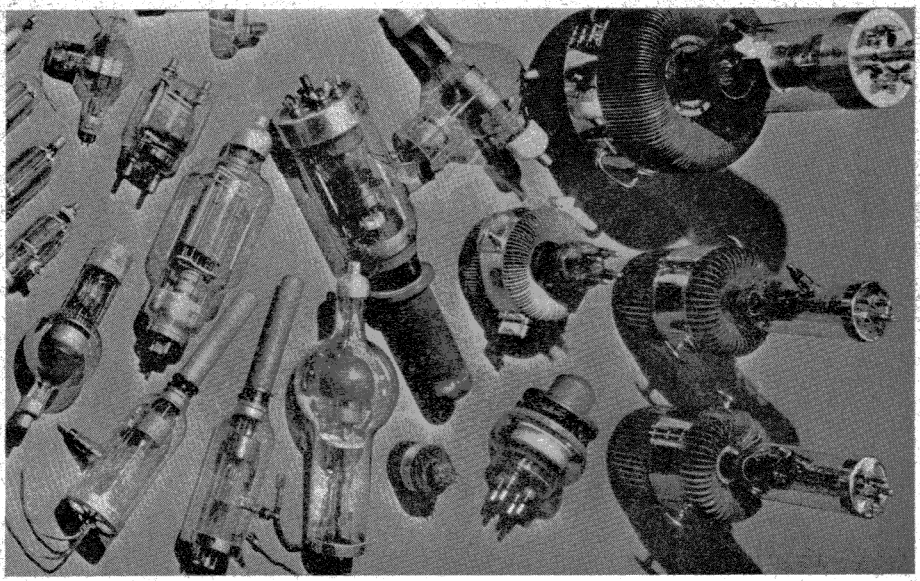


FIG. 31

before any current will start to flow. At approximately 300 volts ionization of the argon gas will take place and with the large voltage present, a high current will tend to flow. The gas in the tube will glow and the internal conductivity of the tube will suddenly become very low. The voltage drop within the tube will reduce to about 25 volts and will remain at almost exactly this value unless the current drops below the minimum required to maintain ionization (about 30 ma.) for the OZ4 and OZ4G tubes. If the voltage drops below 25 volts or the current drops below 30 ma. ionization stops and rectification ceases.

Electrons are driven out of the large oxide surface of the cathode toward the small anode. When the anodes go negative as they must during ½ cycle, the gas is again ionized at about 300 volts, but the anode surface is so small and it is such a poor surface for emission of electrons that not much current can flow from it. Some current does flow for an instant, but it is of no importance. The action of the tube is such that electrons are made to flow much better in one direction than in the other, simply by arranging the surface of the electrodes so that electrons can more easily leave the surface of the cathode than the anode. For example, if the cathode surface is 50 times as large as the anode surface, some 50 times the current will flow from cathode to anode as in the reverse direction.

A typical use of this type of rectifier is given in Fig. 31. Like the mercury vapor tube, some means of over-



Radio tubes have many and varied uses. The above view shows a group of special purpose *General Electric* tubes. Such tubes are made for rectification, for transmitters and for high frequency heating.

coming the noise produced by the rectifier circuit must be employed. This noise is much greater for the cold cathode tube because the starting voltage and ionization voltage are much higher than for the hot cathode mercury vapor tube. The wave analysis is comparable to that of Fig. 28A, although there are certain minor differences as explained.

Mechanical Rectifiers

Out of the necessity of producing a high D.C. voltage from a low D.C. voltage source, such as the automobile storage battery, has come the development of the *mechanical rectifier* more often called the *vibrator rectifier or synchronous rectifier.*

The storage battery, of course, develops a low D.C. voltage and cannot be used directly with a transformer. If the storage battery voltage were applied direct to the primary of a transformer, the transformer core would simply become a closed core electro-magnet, and there would be no voltage whatever at the secondary.

The first method of enabling the automobile storage battery voltage and current to be used with a transformer where it could be stepped up to a high voltage, was to connect the battery to the primary of a transformer thru a device which would *open and close* the circuit a great number of times per second. By thus starting and stopping the primary current, the magnetism of the core was made to build up to a high value, then collapse a number of times per second. This was roughly equivalent to A.C. in the primary because, although not reversing, the primary current was at least varying. A circuit for interrupting the primary current is shown in Fig. 32. The interrupter consists of a solinoid S with an armature A and contact K. As soon as the current through the primary and through S reaches near maximum the magnetism of S is sufficient to pull armature A away from contact K against its spring action. However, as soon as the contact at A-K is broken, the magnetism in S vanishes and the spring action of A returns it to contact K, where the operation is re-

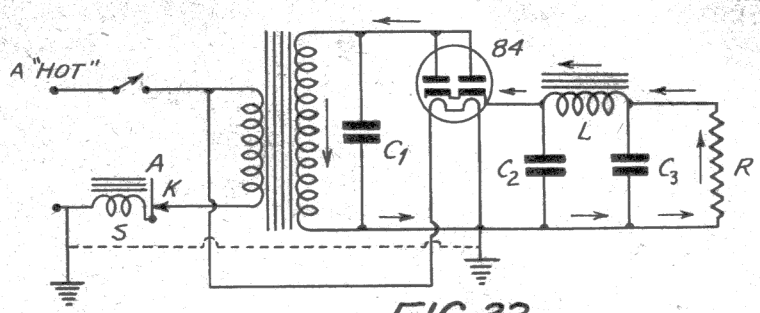


FIG. 32

peated. Whereas the primary current rises gradually because of the action of the primary inductance when the circuit is broken the current from the battery stops almost instantly. Since the secondary voltage is determined in a great measure by the rate at which the magnetism is changing, naturally the the sudden collapse of the magnetic field produces a very high voltage. The secondary voltage is, therefore, quite irregular.

In Fig. 32 a high vacuum rectifier is shown in a half wave rectifier circuit. It should be clear from this diagram that the filament circuit is entirely separate from the rectifier circuit—it being completed through the ground or chassis connection.

To overcome the irregularities in the high voltage, a much better system has been designed as a primary interrupted. It consists of an armature which will allow current to flow first in one half of a centertapped primary and then in the other half. A circuit employing this principle using an OZ4 cold cathode gas rectifier is shown in Fig. 33.

The armature is midway between K1 and K2 before the switch to the battery A is closed. When the switch in the A negative lead is closed, a small amount of current will flow through the top half of the primary through R, S and back to A+. This energizes electro-magnet S and draws it up to contact K1. When the contact K1 is reached by the armature, the current no longer takes the path through R and S, but goes directly through the upper half of the primary to K1, the armature and hence to A+. The resistance of the primary is much lower than R and S. R and S are both completely shorted by K1 in contact with the armature. Consequently, the magnetism of S vanishes

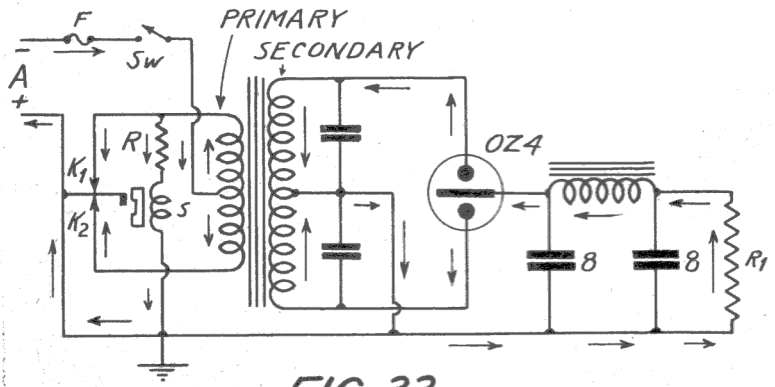


FIG. 33

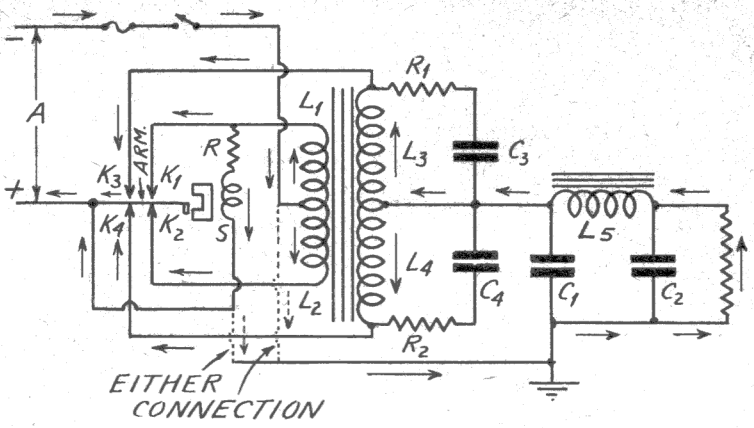


FIG. 34

and the armature is drawn back toward K2 by its own spring tension. It is provided with a weight on its end so that it will swing past its center point and make contact with K2. Contacts K1 and K2 are mounted on spring arms so that contact will be established while the armature is in motion.

In contacting with K2, the current is practically cut off from K1 and a large current builds up in the lower half of the secondary. This, of course, induces a voltage in the secondary of opposite direction or polarity. It is quite easy to see now that it would make no difference whether the current flows from the center of the primary toward each end or from each end toward the center, because the secondary voltage would be the same value in either case.

While the current in the primary is rising in either half of it, a voltage is being produced in the secondary. Therefore, by closing a circuit in one-half of the secondary circuit during the time when the current is rising in one-half of the primary, there will be a secondary current flow also. If the circuit of the secondary side is closed through the filter and load each time the primary current is introduced, rectification will be accomplished mechanically.

This double duty job is done by the four contact interrupter or vibrator as shown in Fig. 34. When contact K1 is connected to the armature, current flows in the L1 section of the primary as shown by the arrow. During this time, contact K3 is also connected to the armature and the transformer is wound so that the current in L1 will induce a voltage in the L3 half of the secondary, in the direction of the arrow.

A voltage in this direction will, of course, be induced in the entire secondary, but no use is made of it in L4 as contact K4 is open at this time. As the armature leaves K1 and K3 it contacts K2 and K4 where a similar action takes place in L2 of the primary and L4 of the secondary. The vibrator action again is the same as mentioned before and a current is drawn in the same direction through L5, the filterchoke, for each primary current pulse.

The resistors R1 and R2 as well as the condensers C3 and C4 are to suppress the excessive voltage of the secondary which is produced when the primary contacts open (caused by the inductance of the secondary). The vibrator shown in Fig. 34 is called a synchronous type, because contacts K1 and K3 must close and open at exactly the same instant, and this is true as well of contacts K2 and K4.

Radio Tube Standards and Ratings

Lesson ND-12—Part 2

This section of the lesson is devoted to tube standards and ratings. There was a time when tube types and makes were so few in number that it was no trouble at all for the radio man to memorize all of the essential information relating to them. Today this would be a practical impossibility because tube types run into the hundreds and several factories are devoted to manufacturing them. Most manufacturers make all of the standard types and, in addition, some of them also make many special types. Thus radiomen no longer rely on their memory for tube information but instead they refer to standard yearly tube manuals put out by the various tube manufacturers. These usually cost a few cents each and are well worth the money. In addition, many of the tube companies make available wall charts which are free to the radio service and repair man. No book or chart is up to date, however, because new tube types are being brought out all of the time. The following companies make tubes. If you are interested in tube manuals, charts, etc., we suggest you write direct to them for more information.

Practically every type of tube requires a *socket* to hold it in place. These sockets have metal terminals to which the circuit wiring is attached. This permits quick and easy change of tubes for testing and replacement. The sockets are made in various sizes and forms to fit standard tube bases which you will find listed in tube manuals. Pins on the base of a tube fit into small holes in the sockets. In this way the tube pins are forced to fit tightly against an extension of the socket terminals and good, firm electrical contact is established between tube base pins and their corresponding socket terminals.

In the past many tube types have been made, and some of them are now obsolete. In general, receiving tube bases and sockets now in com-

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General Electric Co.,
1 River Road, Schenectady, N. Y.

Kenrad Tube & Lamp Co.,
Owensboro, Kentucky

Raytheon Production Co.,
55 Chapel St., Newton, Mass.

Rogers Radio Tubes, Ltd.
Toronto, Ontario, Canada

Hytron Corp.,
76 Lafayette St., Salem, Mass.

National Union Radio Corp.,
15 Washington St., Newark 2, N. J.

R. C. A. Victor Div.,
Radio Corp. of America,
Harrison, N. J.

Standard Arcturus Corp.,
30-34 Court St., Newark 2, N. J.

Sylvania Elec. Products, Inc.,
Emporium, Pa.

Westinghouse Lamp Div.
Bloomfield, N. J.

Tung Sol Lamp Works, Inc.
Radio Tube Div.,
95 8th Ave., Newark 14, N. J.

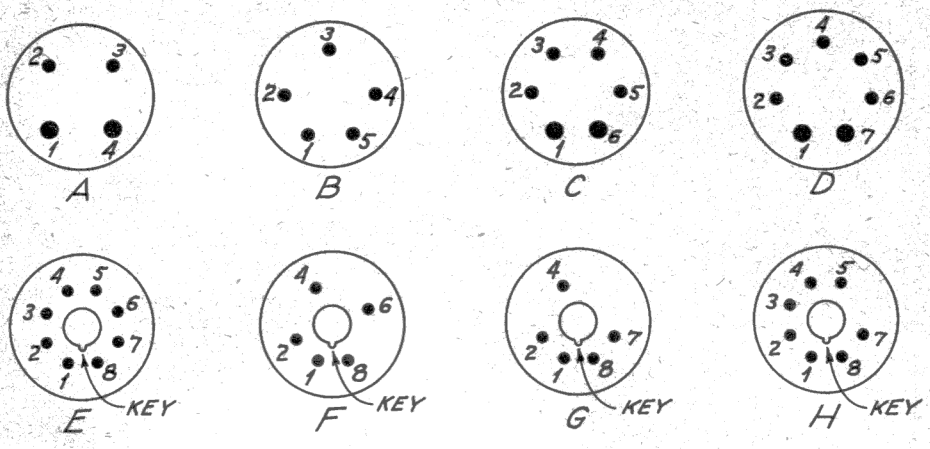


FIG 1 BOTTOM VIEW OF SOCKETS

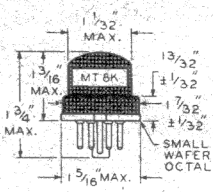
The above drawings show most of the popular tube socket terminal arrangements. Most of the new tubes brought out today make use of a variance of the basic octal socket. See the lesson text for more details.

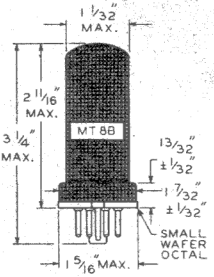
mon use have been restricted to seven types. Thus, most of the tubes you will find in common use are of the 4, 5, 6, 7 and 8 pin variety. There is considerable variation among these seven types, particularly with the 6, 7 and 8 pin types. There are two popular sizes of the 6 and 7 pin types. The difference is in the diameter of the tube bases. The smaller size is called a small base and the next larger size is called a medium base. Examples of the small size base of the 6 pin tube are the 1C6, 57, 58, etc. Examples of the medium 6 pin are the 42, 43, 48, etc. For the small seven pin the 6A7, 12A5 and 12A7 are representative. The medium 7 pin types of tubes are 6A6, 53, 59, etc. It is in the 8 pin types that the most variation is found. Tubes with 8 pins are referred to as the *octal* type—they may also be called the *loctal* type which refers to a particular lock-in feature whereby they are locked in place in their sockets and are not so likely to slip out of their sockets in mobile equipment.

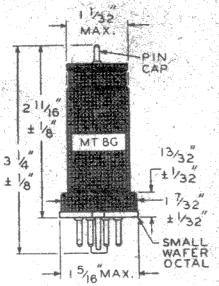
Octal and loctal tubes are of the latest design and most new tubes brought out use this type of base. *They may use up to a maximum of eight pins and down to a minimum of three pins.* This type of base also has a key in the center of its base. It fits into a keyway of the socket which makes it impossible to put the tube in its socket in the wrong position.

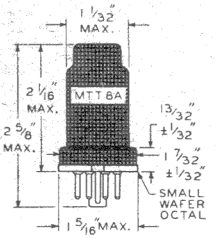
The different types of popular tube sockets are shown in Fig. 1. Note the terminals of the sockets are numbered from 1 to 8. This pin numbering follows the standard system as advocated by the R. M. A. or Radio Manufacturers Association. At A is shown the pin arrangement for 4 pin tubes, B is for 5 pin tubes, C is for 6 pin tubes and D for 7 pin tubes. These are bottom *views* as you would look down on the tube pins if they were turned up towards you. As most radio men work on a receiver chassis with it turned up-side down, it is more convenient and less confusing to show bottom views of tubes and sockets. Printed drawings and references will then correspond to both tubes and sockets when you are looking down on them.

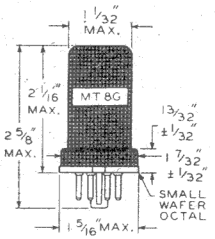
Note in Fig. 1 at A that pins 1 and 4 are larger than 2 and 3. This is also true at B, C and D where pins

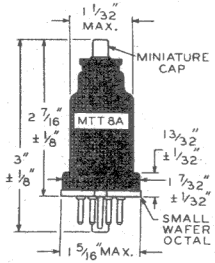


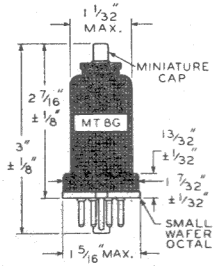




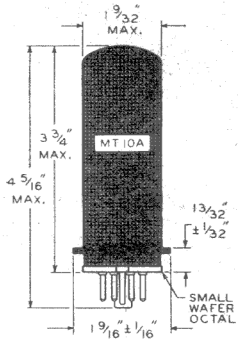




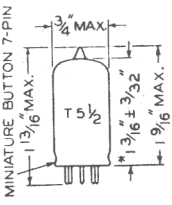


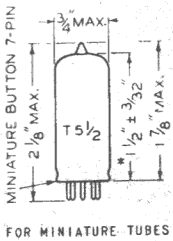


In tube manuals and other manufacturers' literature, reference will be made to certain tube outlines or shapes by such designations as MT8K, MT8G MT10A, etc. The letters MT refer to a metal type tube. The two figures on this page show the various metal tube outlines.
Courtesy of RCA.



Miniature tube outlines are shown below. These are small type tubes with an all glass base. Examples are the 6AQ6, 6AL5 and 6J4.
Courtesy of RCA





*Measured From Base Seat To Bulb-Top Line As Determined By Ring Gauge Of 7/16" I.D.

1 and 5, 1 and 6, 1 and 7 are larger than the others on the same socket. This arrangement was formerly used to identify the two filament or heater terminals of a tube. Because of the large consumption of current, the filament terminals needed to be larger than the other pins in order to carry the current without overheating. Today, refinement of tubes and circuits have eliminated the need of large pins for the tube filament. As a consequence the pins on most modern tubes of a given type are all the same size. Since practically any new tube brought out today will fit one of the standard sockets shown in Fig. 1, the R. M. A. numbering system will enable you to identify the proper socket terminals or tube pins for any type of tube. Elsewhere in this lesson you will find more information on tube bases and sockets.

All tube manufacturers' manuals give the pin numbers for the various tubes. For instance, the R. C. A. tube manual gives the following pin information about the 6A8, 6A8-G and 6A8-GT tubes:

Pin No. 1—Metal shell or ground
Pin No. 2—Heater
Pin No. 3—Plate

Pin No. 4—Grids No. 3 and 5
Pin. No. 5—Grid No. 1
Pin No. 6—Grid No. 2
Pin No. 7—Heater
Pin No. 8—Cathode

Thus, with this information you can refer to or memorize the pin arrangement shown in Fig. 1 and immediately identify proper socket terminals. Some tube manufacturers like Sylvania include not only the pin numbers but also the tube element designation in the drawings of their tube manuals. See Fig. 2.

Many tubes employ an extra connection brought out at the top of the tube envelope. On diagrams this is usually labeled TC (meaning top connection or top cap). This same connection may also be labeled CAP in many diagrams. The element to which it connects inside of the tube is usually the *control grid* but this is not always the case. The octal and loctal types of construction permitting up to 8 pins on a tube base made possible the elimination of the TC connection. The normal or usual TC connection is simply brought down to a pin on the base of the tube just as for the other pins. Tubes which have this type of construction with no external TC connection are called *single ended* tubes in contrast to those which have connections at both ends of the tube.

You will note reference has already been made to grid numbers. The order of numbering is from the cathode towards the plate. Thus, the grid next to the cathode will be No. 1, the next grid No. 2, etc. The function of the various grids will be described in your other lessons.

Frequently on tube socket or tube pin diagrams other letter designations are used. A typical list of these follows:

A —Anode
A1 —Anode No. 1
A2 —Anode No. 2
D1 —Deflector No. 1
D2 —Deflector No. 2
D3 —Deflector No. 3
D4 —Deflector No. 4
Dp —Diode Plate
F —Filament
Fc —Filament Center
G —Control Grid
Ga —Anode Grid
Gm —Modulator Grid
Gs —Screen Grid
H —Heater
Hc —Heater Center
Ht —Heater Tap
Ic —Internal Connection
Is —Internal Shield
J —Jumper
K —Cathode
Nc —No Connection
P —Plate
Rc —Ray Control
S —Metal Shield
SA —Starter Anode
Su —Suppressor Grid
T —Target
TC —Top Cap
XS —External Shield
⟿→—Locating Pin or Keyway

The foregoing is not a complete list because tube manufacturers do not standardize on all of their symbols and tube designations. This list is, however, a good general one to be used as a guide.

Tube Letters and Numbers

In the early days of radio no definite identification system was in use whereby tubes were designated by an orderly system. Thus, one manufacturer would bring out a tube and label it 201, 235, 245, 171, etc. Another manufacturer would make the same type of tubes and label them 401, 435, 445, 471, etc. As more tubes were brought out this led to more and more confusion. Thus, it was decided to eliminate the first digit in the number system and manufacturers labeled their tubes with only two numbers. The tubes

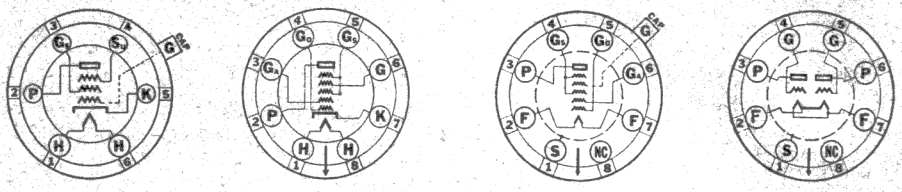


FIG. 2

were then designated as '01, '35, '45, '71, etc. This was the first step towards standardization.

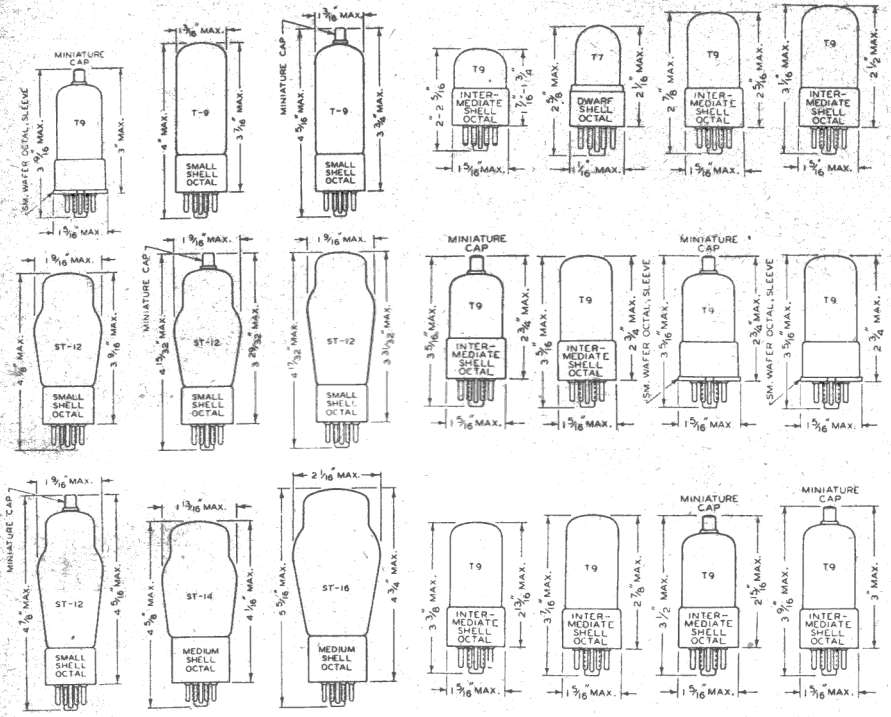
The next step in standardization was sponsored by the Radio Manufacturers Association. This system made use of (1) a *number group* such as 1, 2, 3, 5, 6, etc., (2) a *letter group* such as A, B, C, Z, W, X, U, etc., (3) and a *second number group* such as 1 to 7. In addition some types of tubes employ a *second letter group* such as G, GT, MG, etc.

The first number group usually refers to the filament voltage of the tube. The number 1 in the first number group signifies the filament voltage of the tube may be anywhere in the range from 1 to 2 volts. An example is the 1A1 or 1N5 tube.

The second part of the R. M. A. system is the letter in the designation. This, in general, refers to the "development time" of the tube. Thus, most signal carrying tubes start with the letter A and continue with new letters being added as new tube types are brought out. The progression in this case is usually from A towards Z. Examples as 1A7, 2A7, 2E5, 6A6, 6A8, etc. For rectifiers and other special purpose tubes a reverse progression of the alphabet is used from Z towards A. Examples are 5Z3, 5Y4, 5X4, 5W4, 5V4, 6X5, 6W7, 6V6, 6U7, 6U5, etc.

The third part of the R. M. A. system is a number and refers to the useful elements within the tube. Thus a 6A3 is a 6-volt tube with three useful elements, it being a triode power tube. The 6A4 is a 6-volt power amplifier pentode. It has one or more grid than the 6A3 with respect to its pin connections. In addition it also has a third grid but it is connected inside of the tube to the center of the filament. Since this third grid has no external connection it does not count as a useful element. If its third grid had been brought outside of the tube, the designation would have been 6A5 instead of 6A4. Note in this system the filament is counted as only one useful element even though it employs two pins on the tube base.

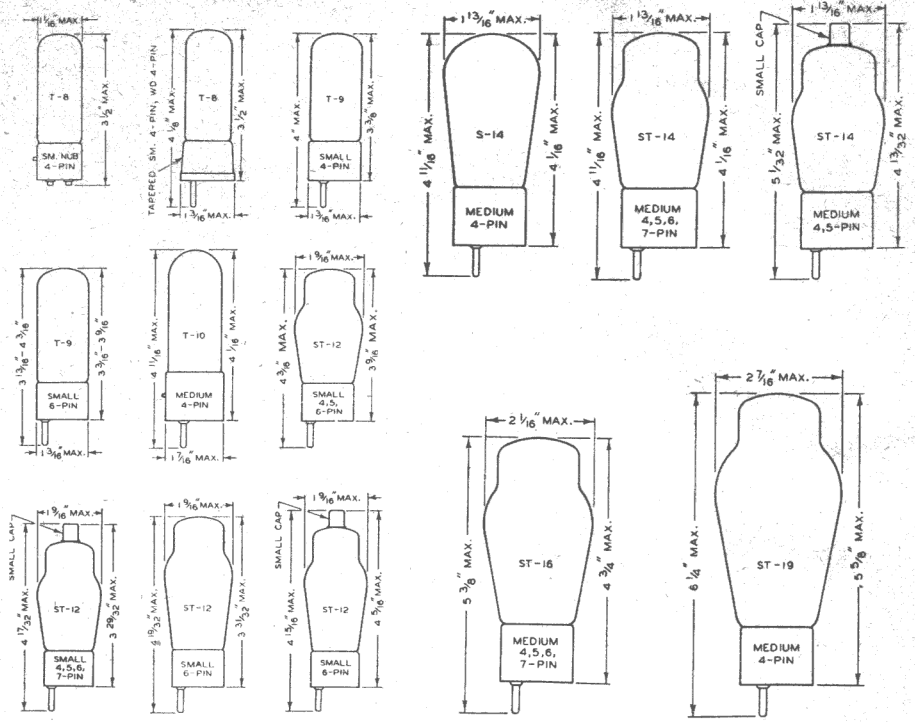
This designation worked fairly well for a long time until metal tube envelopes were introduced. Metal tubes employ a pin on the base for using the metal tube envelope for shielding purposes. Thus, this metal envelope must be counted as a useful tube element. With metal construction a tube that would ordinarily be labeled for example 6F4 must be called a 6F5 because of the metal envelope or shield. It soon became the practice to make glass envelope equivalents of the metal envelope type tubes. Thus, a glass equivalent of the 6F5 was called a 6F5G—the G meaning glass envelope. Therefore a tube that would ordinarily be called a 6F4 was labeled 6F5G despite the fact that the tube only had 4 useful elements. Thus, the original designation system began to lose its accuracy. Because of this and other differences, it is often necessary for the radio man to rely on his memory or look up a tube in a tube manual before he can be sure of the type of tube under question.



Here are more tube outlines. These are of the glass envelope type with octal bases. When a reference is made to the tube size, base or envelope you can refer to these drawings for exact dimensions. *Courtesy of RCA.*

The next major change in tube types was the loctal or lock-in type tubes. These tubes lock in their sockets by means of a metal ring in the socket which locks onto the keyway of the tube base. After this type tube has been inserted in its socket it can not be removed by pulling straight up but must first be moved to one side which releases the lock-in ring; a straight pull on the tube will then permit removal from the socket.

In this type of tube so called "nominal" voltage ratings for the filament are employed. For instance, a *nominal* rating of 7 volts is given to 6.3 volt tubes to distinguish this type of tube from the usual glass or metal envelope type tube. Tube types 7A4, 7A5, 7A6, 7B7, 7C7, etc., are examples of this type of designation. In like manner, a *nominal* rating of 14 volts is applied to certain 12.6 volt tubes to distinguish them from the older type of construction. Examples are 14A7, 14B8, etc. The *nominal* rating as used in these instances such as 7 and 14 means the tubes will operate satisfactorily on 6.3 and 12.6 volts respectively—the numbers 7 and 14 referring specifically to the lock-in type of construction. Several of the low-voltage tubes use the letter L to indicate the lock-in feature. Examples are 1LN5, 1LH6, 1LA6, etc. There are exceptions even to this rule. For instance, the 1LN5 is similar to the 1N5. If the rule were followed literally the only difference between the 1LN5 and 1N5 should be in the tube base construction. Actually the suppressor grid of the 1LN5 is connected to a pin on the tube base while in the 1N5 this same grid is connected to the filament within the tube. This

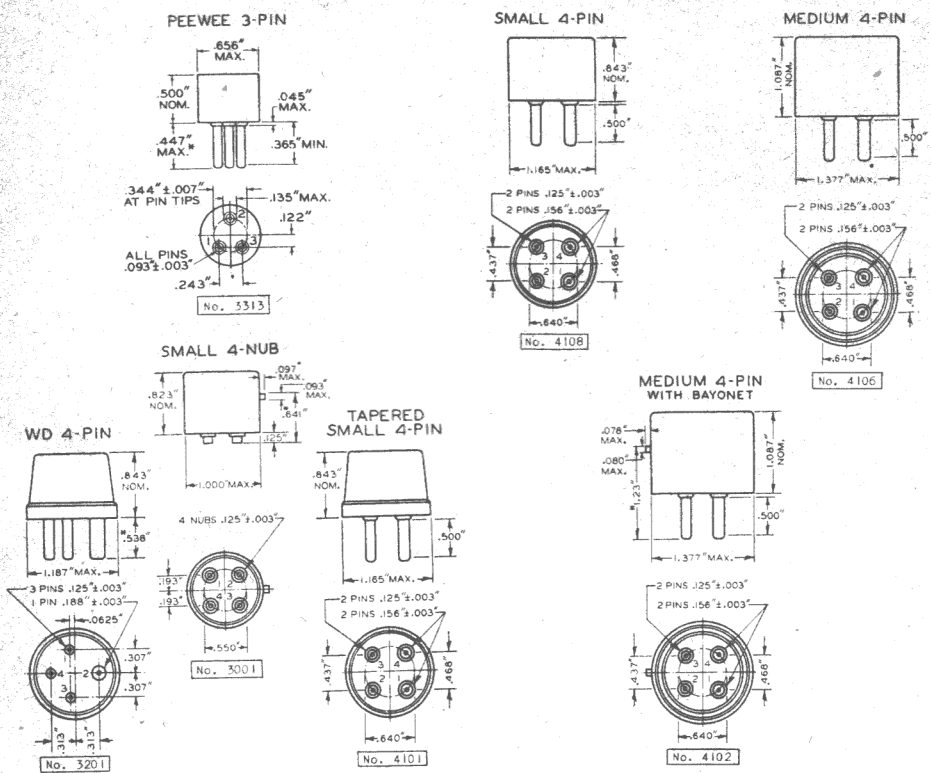


In the above group you will find outlines of the glass envelope type tube using the 4, 5, 6 and 7 pin bases. *Courtesy of RCA.*

represents the type of tube detail that the practical radio man should not try to memorize but should refer instead to tube manuals for this information.

Another change in tube design and designation was brought about when single-ended metal and glass tubes were developed to take the place of certain double-ended tubes. The lock-in type tubes have no TC connection, and it was found desirable to design other standard tubes to include this feature. Thus the "S" series tubes came into being. The difference between a 6SK7 and a 6K7 is that the 6K7 employs a TC connection at one end of the tube for the control grid. Other similar examples are the 6SJ7 and 6J7; 6SS7 and the 6S7. As in other tube designation systems, exceptions occur in the "S" series. Thus the 6SA7 is not a duplicate of the 6A7 because the 6A7 has an older type base and there is no metal envelope equivalent with TC for the 6SA7. The original converter tubes required 9 external connections. This allowed 8 on the tube base and 1 TC connection. This would not, of course, work out for the "S" series of tubes so a new type converter was arranged with 7 elements including the shell. The 6SA7 is of this latter type of construction, and the foregoing will explain why it is not a duplicate of the 6A7. These minor differences seem to creep in regardless of the tube designation system used.

Another change in tubes was the reduction in size of the tube envelope. The 6J7G tube is an example. When a reduction in tube size was applied to a tube which was already standard, the letter T was added—meaning tubular glass envelope. Thus a tube like the 6J6G



The above types of drawings will give you the outlines of 3 and 4 pin tube bases. Note these same dimensions indicate the size of socket which may be used with a given tube base. *Courtesy of RCA.*

under this new system was called a 6J6GT. This change required excess stock inventories by dealers. Thus, tubes with the letter T such as the 6J7GT were marked 6J7GT/G which meant this later type tube could replace a 6J7G or a 6J7GT, and in some cases the 6J7GT/G will also replace a 6J7 depending on the circuit use. The same general principles apply to other tubes with G, GT and GT/G ratings.

First Number Group of Tube Designation

As already mentioned, the first number or group of numbers as applied to a radio tube refers to the value of the filament voltage. The following list gives the details and exceptions to the general rule.

0—refers to a cold cathode meaning no heater or filament is required. An example is the 0Z4. The exception is the 01A, 00A, etc., which are very early type tubes.

1—indicates filament voltage from 1 to 2.1 volts. The exception is the 1V from the early system of numbering.

2—indicates filament voltage from 2.1 to 2.9 volts. The exception is the 2.8 volt series of tubes which are marked 3A8, 3LF4, etc.

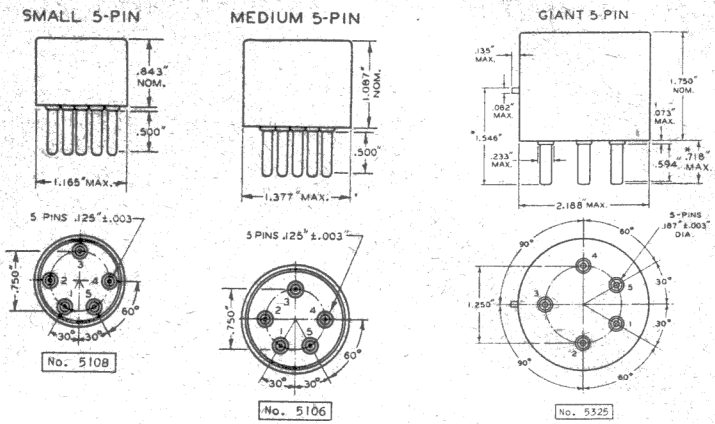
3—indicates filament voltage from 3 to 3.9 volts.

5—indicates filament voltage from 5 to 5.9 volts.

6—indicates filament voltage from 6 to 6.9 volts.

7—indicates filament voltage from 7 to 7.9 volts.

The foregoing general system is in use on up to 25 volts. When the filament voltage exceeds 25 volts, the



Here is shown the base outlines of the various 5 pin tube bases. Note the standard RMA numbering system is used for the pins. This, of course, corresponds to the socket numbering as well. *Courtesy of RCA.*

first group of numbers of a tube's designation indicates the actual value of the filament voltage. The 25L6, 35Z5, 50L6 and 117P7 are examples.

When the heater or filament is tapped for use on two voltages, the higher voltage is used. The exception to this rule is the 6Z5 which may also be used on 12 volts.

With respect to cathode-ray tubes, the first group of numbers refers to the diameter of the screen on the end of the tube instead of the filament voltage. Later lessons in your S. A. R. course will give complete details on cathode-ray tubes.

Nominal ratings of 7 and 14 refers to actual filament voltage ratings of 6.3 and 12.3 volts respectively.

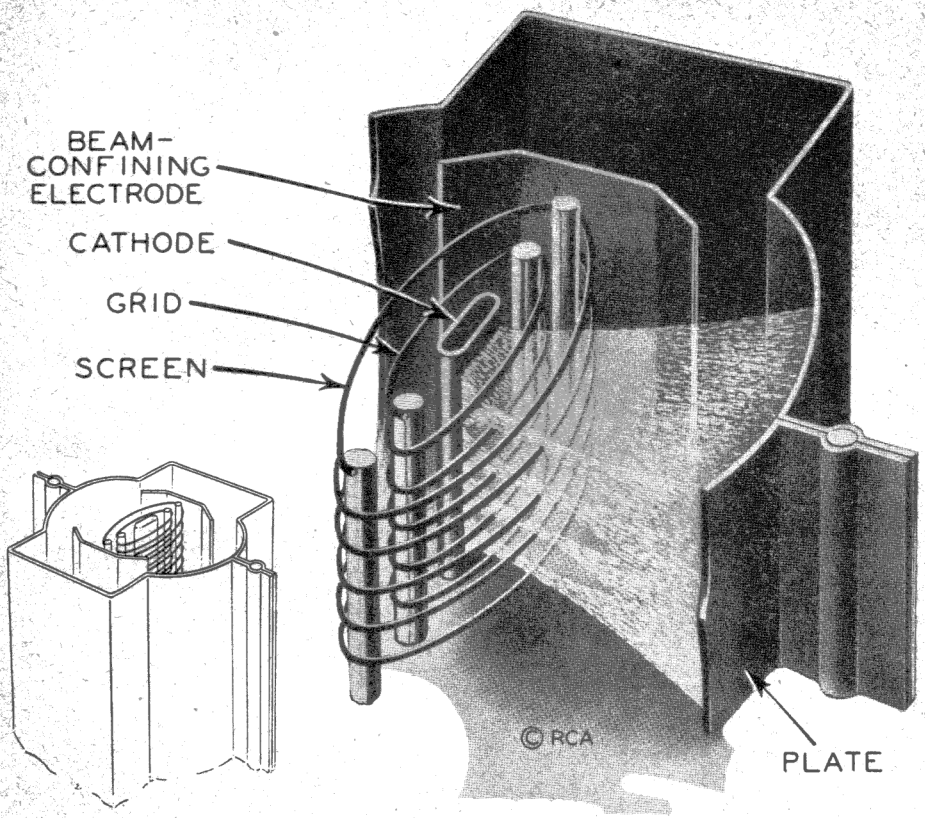
First Letter Group of Tube Designation

When letters were first used in connection with a tube's designation, it was intended that certain letters would refer to certain tube types, and this remained generally true. Thus, the letters U, V, W, X, Y and Z are commonly used to indicate rectifiers. The exceptions are 6U7G, 6UG, 6U6GT, 6V6G, 6U7G, 6W7G, 6Y6G, 6Y7G, 6Z7G, 7V7, 7W7 and 14W7. The foregoing tubes may be identified by referring to any good tube manual.

The letter "S" in the first letter group in general refers to single-ended tubes with no TC connection. The exceptions are 6S7, 1S4, 1S5, 7S7. The 6SS7 is, on the other hand, of the single-ended type.

Second Number Group of Tube Designation

Under this heading the numbers 1 to 8 occur and refer to the number of *useful elements* brought outside of the tube to external connections. The metal envelope of metal type tubes acts as a shield and counts as one element. For the type 6A5G tube the heater and cathode are connected internally, but their connections are brought outside of the tube thus counting as two elements. If the base of the tube is metal it does not count as a useful element. There are exceptions to this latter rule where the filament tap or shielding lug counts as one element. Examples of this are the 7G8, 28Z5, 3D6, 7C4, 7E5, 3B7, 7W7, 7A8, 35Z5GT, etc. Confusion exists here because there has been no standard agreement among tube manufacturers for filament center taps, shielding lugs, suppressor grids when connected internally and split screen grids when referred to as useful elements.



ELECTRON BEAM SHEETS FORMED BY GRID WIRES

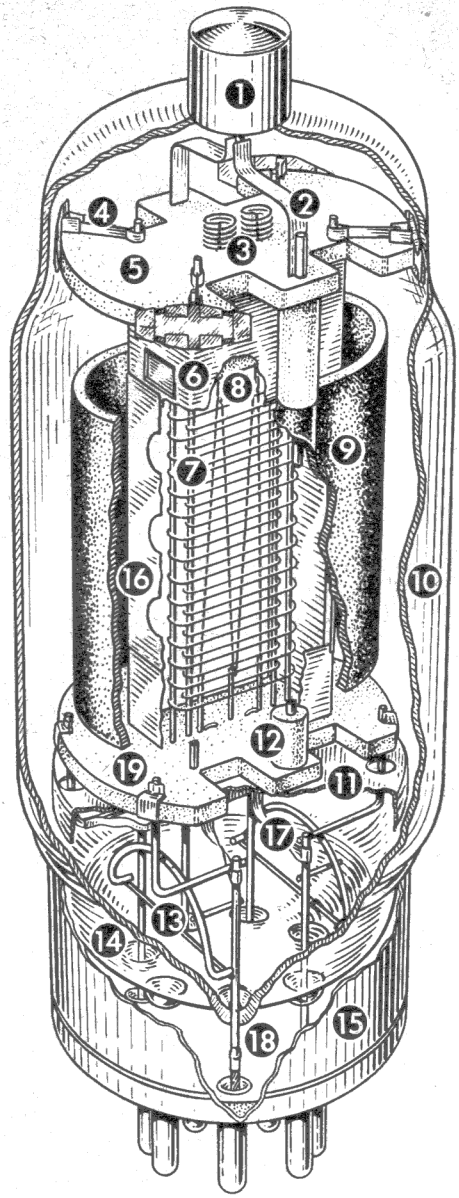
The above view shows a type of tube construction which will be described later on in your S. A. R. lessons. It is called a "beam power amplifier." It has particular application in the output stages of a radio—developing maximum power for the speaker. *Courtesy of RCA.*

Double Letters in First Letter Group

Some types of tubes employ more than one letter in the first letter group. Examples are AB, AC, AD and AE. This was resorted to when all single letters of the alphabet were used. Where the letter L precedes a letter, it refers to the lock-in feature, and when S is used as the second letter of the group, it refers to single-ended construction. The use of the letter P as the second letter of the group refers to a cathode-ray tube such as the 3BP1.

Last Letter Group

In the last letter group of a tube's designation, certain letters are used to denote certain features. The letter A is used to indicate a quick heater type tube such as the 24A. Another use for the letter A is to indicate tubes of reduced filament current with respect to the same type number. Examples are 01-01A, 12-12A, 71-71A, etc. Still another use of the letter A is to denote smaller tube envelope size as in the case of the 6L6GA. The letter A may also be employed to denote other minor



1 MEDIUM METAL CAP

2 SHORT RIBBON PLATE CONNECTOR

3 FILAMENT SUPPORT SPRINGS

4 GROUNDED MOUNT CUSHIONS

5 TOP CERAMIC MOUNT SUPPORT

6 TOP SHIELD

7 ALIGNED-TURN CONTROL AND SCREEN GRIDS

8 HEAVY-DUTY THORIATED-TUNGSTEN FILAMENT

9 LARGE GRAPHITE PLATE

10 HARD-GLASS BULB WITH MOUNT-ALIGNING DOME

11 BOTTOM SHIELD DISC

12 CERAMIC PLATE-SUPPORT SPACERS

13 DIRECTIVE-TYPE GETTER CONTAINER

14 DISH-TYPE STEM

15 CERAMIC-INSERT GIANT BASE

16 BEAM-CONFINING ELECTRODE

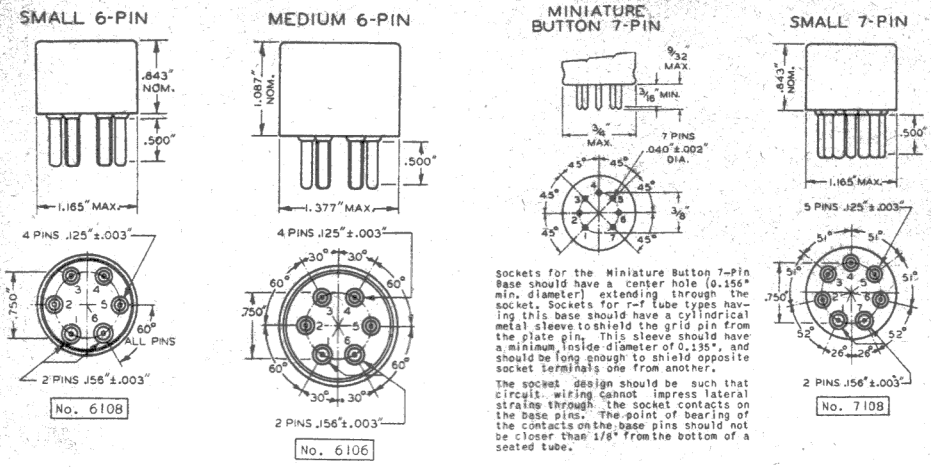
17 FILAMENT CONNECTOR

18 TUNGSTEN-TO-GLASS SEAL

19 BOTTOM CERAMIC MOUNT SUPPORT

STRUCTURE OF TRANSMITTING BEAM TUBE
RCA-813

The same principles which permit a receiving tube to operate are also applicable to transmitting tubes. The above view shows a typical RCA beam transmitting tube with the principal parts identified.


SMALL 6-PIN
.843" NOM.
.500"
1.165" MAX.
4 PINS .125"±.003"
.750"
60°
ALL PINS
2 PINS .156"±.003"
No. 6108
MEDIUM 6-PIN
1.087" NOM.
.500"
1.377" MAX.
4 PINS .125"±.003"
30°
60°
.750"
2 PINS .156"±.003"
No. 6106
MINIATURE BUTTON 7-PIN
9/32" MAX.
3/16" MIN.
3/8" MAX.
7 PINS
.040"±.002" DIA.
45°
3/8"
Sockets for the Miniature Button 7-Pin Base should have a center hole (0.156" min. diameter) extending through the socket. Sockets for r-f tube types having this base should have a cylindrical metal sleeve to shield the grid pin from the plate pin. This sleeve should have a minimum inside diameter of 0.135", and should be long enough to shield opposite socket terminals one from another.
The socket design should be such that circuit wiring cannot impress lateral strains through the socket contacts on the base pins. The point of bearing of the contacts on the base pins should not be closer than 1/8" from the bottom of a seated tube.
SMALL 7-PIN
.843" NOM.
.500"
1.165" MAX.
5 PINS .125"±.003"
51°
.750"
52°
26°
2 PINS .156"±.003"
No. 7108

Here are more tube base outlines. These show the dimensions for 6 and 7 pin tubes. Note the spacing between pins and their relative size. Such dimensions are important when tube sockets must be replaced or when you want to know in advance how much space a given tube will occupy. *Courtesy of RCA.*

changes which do not, in general, affect the operation of the tube.

The letter E may sometimes be used in export tubes to denote minor construction changes.

The letter G indicates glass envelope, usually size ST-12 to ST-16. GT refers to glass envelope size T9. GT/G refers to glass envelope size T9 and further indicates, in general, that the tube is interchangable with similar types of G and GT tubes.

The letter H indicates a tube employing a horizontal assembly instead of the vertical type. An example is the 1F7GH. The letter H may also refer to the use of a cathode where the tube originally employed a filament only. An example is the 2A3H.

The letter L, of course, refers to the lock-in type of construction. The use of LA is not a final letter group because these letters were originally used to indicate a certain type of tube.

The use of LT, ML and LM refers to a glass or metal envelope type tube but fitted with a lock-in base. MG refers to a combination of metal-glass construction—it really being a glass envelope enclosed within a metal envelope.

The letter P refers to pentode type of construction as in the case of the 1B4P. Some tubes were made with metal sprayed or soldered around the glass envelope. These were called spray shield tubes and employed the letter S for this designation—such tubes were made principally for Majestic receivers.

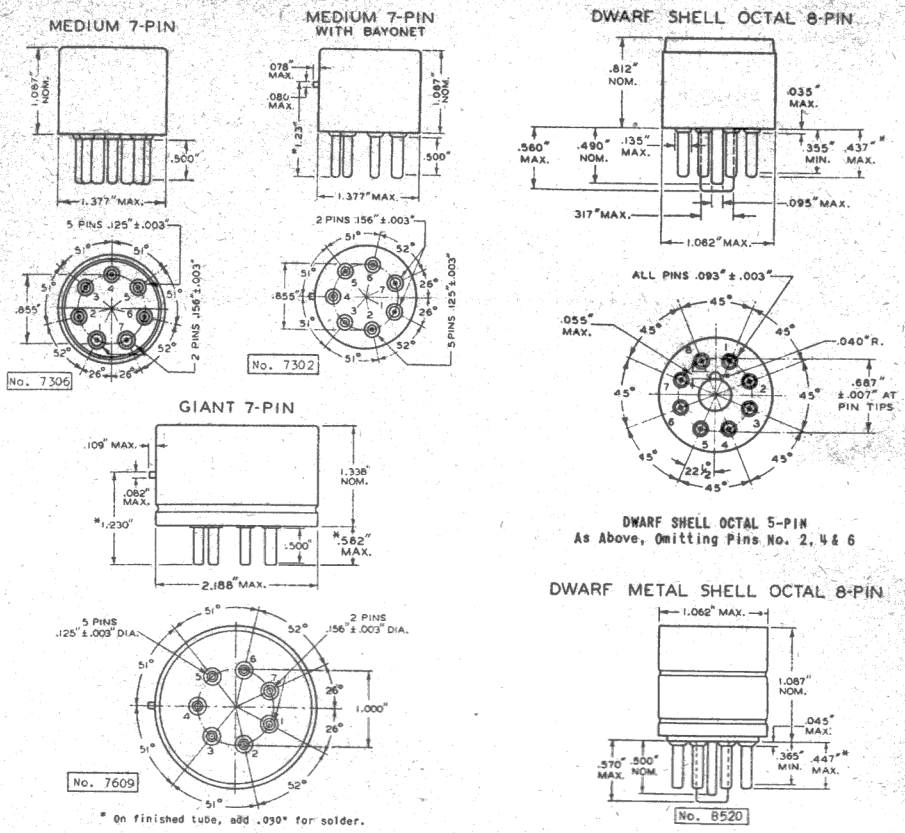
The letter T refers to tetrode construction as in the case of the 1B4T. T may also be used for transmitter tubes to indicate special construction as in the case of the 210-T.

The letter V indicates vertical assembly as in the case of the 1F7GV.

The letter X is used to indicate a low loss base for high frequency use. The material used is usually ceramic. The letter Y is for the same purpose indicating phenolic insulation.

6 Volt Versus 12 Volt Tubes

Ordinarily the 12 volt series of tubes retains the same letters as the equivalent 6 volt tube. For instance, the 6A8GT and 12A8GT are alike except for filament rating. This system is not always followed, and there are exceptions to the rule. For instance, the 7C7 is similar to the 14C7, but there are minor differences. The same is true for the 7A5



These are typical examples of two sizes of 7 pin tube bases. The medium pin tube bases are in most common use. The giant size is used for such tubes as the 59. The illustration to the right shows base dimensions for the dwarf octal 8 pin bases. *Courtesy of RCA.*

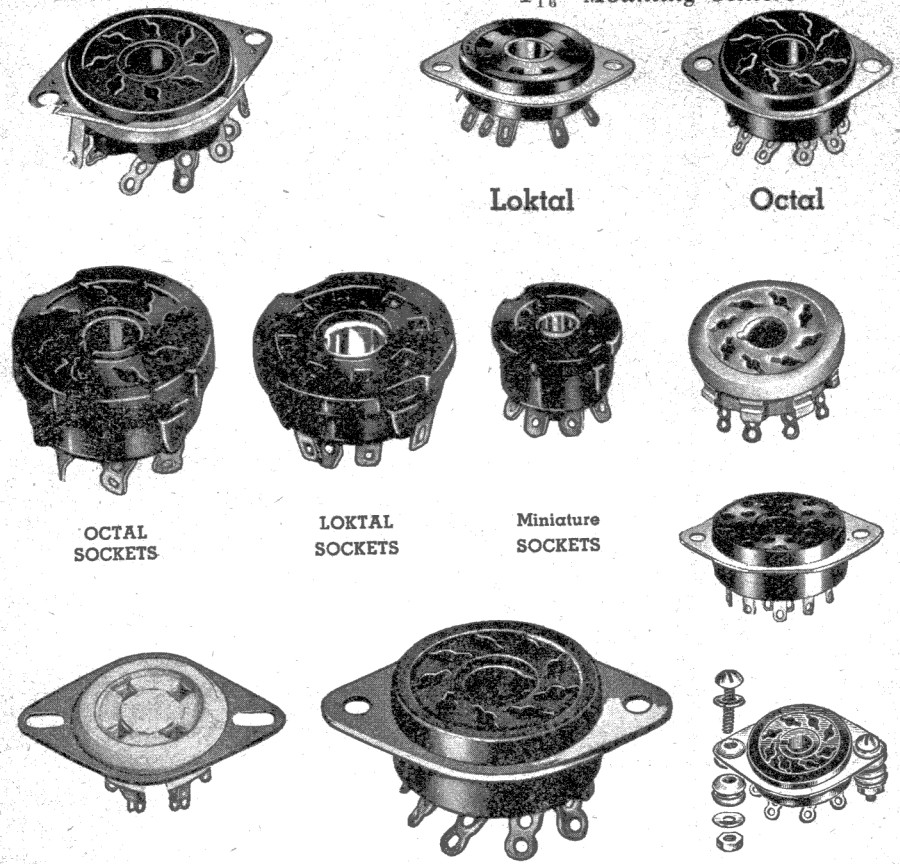
and the 14A5. Characteristics *are not similar* for the following 6 and 12 volt tubes: 6A7-12A7; 6A5-12A5; 6B8-12B8; 6C8-12C8; 6B7-12B7.

At the time of this writing, certain other letters and numbers are coming into use, but not enough information is available to merit their inclusion at the present writing. As soon as this new system comes into more general use and is standardized, it will be included in the S. A. R. course.

Classification of Tubes

Radio receiving tubes are usually classified according to their type. There are several tubes of the same type but with varying *filament* voltage ratings.

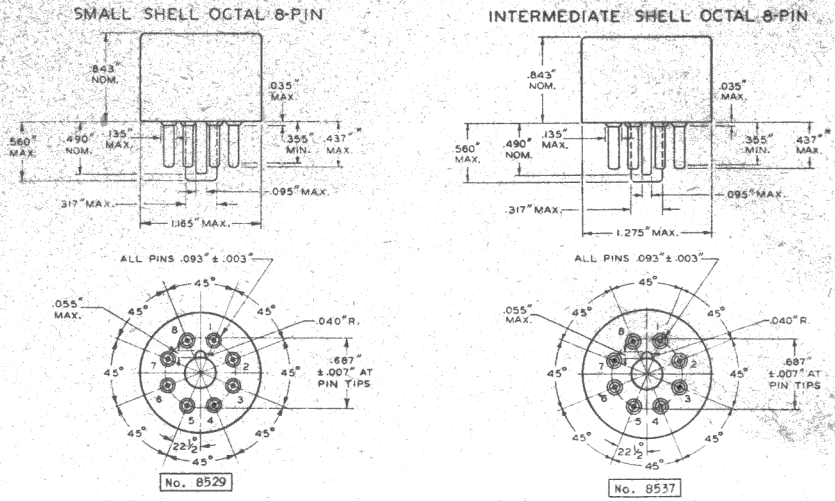
The usual classification includes Rectifiers, Diode Detectors, Amplifiers and Power Amplifiers with and without rectifiers (in the same tube envelope). The latter class is usually subdivided into Triode, Beam Tubes and Pentodes. Next there are converters and mixers which are usually used in superheterodyne type receivers. Electron-Ray tubes are usually used as tuning indicators and for measurement work—they are made in both single and twin units. Under the heading of voltage amplifiers is a wide variety of tubes with subdivisions. This type of tube can also be



Tube sockets are made in various sizes and shapes. They are usually made with mounting holes which permit mounting them on a metal chassis with machine screws and nuts or rivets. Larger holes in the chassis are usually punched out by hand or press punches. When replacing a given socket, always make sure it is of correct type and size.

used as an oscillator in superheterodyne receivers. They come in single and multiple purpose units. Thus, one tube envelope may combine several functions. Under triodes of voltage amplifiers there are medium-mu and high-mu types; under tetrodes there are remote cut-off and sharp cut-off types; and under pentodes there are remote cut-off, semi-remote cut-off and sharp cut-off types. (Cut-off refers to complete reduction of plate current.)

Special Note: In the foregoing and in much of the following, many new terms are mentioned which have not been given detailed treatment in your lessons up to now. It is not possible to give full explanations of each new term without bringing up many other new subjects which cannot be given adequate treatment here. So remember full explanations will be given later on in other lessons. The tube information given here is for your *reference*—to be referred to throughout the study of your S. A. R. course.



Here are two types of octal 8 pin tube bases. You will need to refer to a manufacturer's tube manual when using this and other standard data given in this lesson. All of the various figures given in this lesson indicate the close engineering tolerances followed in the radio industry.
Courtesy of RCA.

Rectifiers

HALF WAVE HIGH VACUUM RECTIFIERS: There are none of these in the 1 to 5 volt types of tubes. The 1V is available at 6.3 volts. Several types are available in the 12 to 45 volt series. These are 12Z3, 35Z3, 35Z4GT, 35Z5GT/G, 45Z5GT and 45Z3.

FULL WAVE HIGH VACUUM RECTIFIERS: The 5 volt filament rating includes the following types—5T4, 5U4G, 5X4G, 5Z3, 5W4, 5W4GT/G, 5Y3GT/, 5Y4G, 80, 5Z4, 5V4G and 83V. For 6.3 volt filament operation there are the following types—6X5, 6X5GT/G, 84/6Z4, 6Y5, 6Z5, 6ZY5G and 7Y4. The 6Z5 may also be operated at 12.6 volts.

MERCURY VAPOR FULL WAVE RECTIFIERS: 2.5 volts—82; 5 volts—83.

COLD CATHODE FULL WAVE RECTIFIERS: (No filament voltage required)—0Z4 and 0Z4G.

VOLTAGE DOUBLER FULL WAVE RECTIFIERS: 25 volts—25Y5, 25Z5, 25Z6 and 25Z6GT/G; 50 volts—50Y6GT/G; 50Z7G; 117 volts—117Z6GT/G.

Detectors

DIODE DETECTORS: This type of detector is also combined with other type tubes which will be found listed later on. There is a one plate

diode and it is the 1A3 operated at 1.4 volts. The double plate diode units include the 6H6, 6H6GT/G and 7A6 at 6.3 volts. The 12.6 volt type is the 12H6.

Power Amplifiers

This classification also includes power amplifiers which combine rectifiers, diode detectors and voltage amplifiers in the same tube envelope.

TRIODE LOW MU: 2 volts—31; 2.5 volts — 2A3, 45 and 183/484; 6.3 volts—6A3 and 6B4G.

TRIODE LOW MU TWIN UNIT: 6.3 volts—6E6.

TRIODE HIGH MU SINGLE UNIT: 2 volts—49; 2.5 volts—46; 6.3 volts—6AC5GT/G; 25 volts—25AC5GT.

TRIODE HIGH MU TWIN UNIT: 1.4 volts — 1C6GT/G; 2 volts—1J6G and 19; 2.5 volts—53; 6.3 volts—6N7, 6A6, 6N7GT/G, 6Z7G, 6Y7G and 79.

TRIODE HIGH MU DIRECT COUPLED: 6.3 volts — 6B5, 6N6G; 25 volts—25B5 and 25N6G.

BEAM POWER SINGLE UNIT TUBES: 1.4 volts — 1Q5GT/G, 3Q5GT/G (this tube may also be operated at 2.8 volts) and the 1T5GT; 6.3 volts — 6L6, 6L6G, 6Y6G, 6V6, 6V6GT/G, 7A5 and 7C5; 25 volts—25C6G, 25L6 and 25L6GT/G; 35 volts—35A5 and 35L6GT/G; 50 volts—50L6GT.

BEAM POWER TUBES WITH RECTIFIERS: These are mostly in the high voltage class and the following designations will indicate the filament voltage. 35L7GT, 70L7GT, 117L/M7GT, 117P7GT and 117N7GT.

PENTODE SINGLE UNIT POWER AMPLIFIERS: 1.4 volts—1A5GT/G, 1S4, 3S4 (also operates at 2.8 volts), 1C5GT/G, 1LA4, 1LB4 and 3Q4 (also operates at 2.8 volts); 2 volts—1F4, 1F5G, 1G5G, 1J5G and 33; 2.5 volts—2A5, 47 and 59; 6.3 volts—6F6, 6F6G, 42, 6G6G, 38, 6AG7, 89, 6K6GT/, 41 and 12A5 (parallel operation). Other tubes under this classification with various voltage ratings are 12A5 (series operation), 25A6, 25A6GT/G, 43 and 25B6G.

PENTODE WITH MEDIUM MU TRIODE—6AD7G.

PENTODE WITH DIODE — 1N6G.

PENTODE WITH DIODE AND TRIODE—1D8GT.

PENTODE WITH RECTIFIER —12A7 and 25A7GT/G.

PENTODE TWIN UNIT — 1E7G (equivalent to two 1F5G's in one envelope).

Converters and Mixers

CONVERTER PENTAGRID: 1.4 volts — 1A7GT/G, 1B7GT, 1LA6, 1R5; 2 volts—1C6, 1C7G, 1A6 and 1D7G; 2.5 volts—2A7; 6.3 volts — 6A8, 6A8G, 6A8GT, 6A7, 6A75, 6D8G, 6SA7, 6SA7GT/G, 7B8 and 7Q7; 12.6 volts — 12A8GT/G, 12SA7 and 12SA7GT/G.

CONVERTER TRIODE-HEXODE: 6.3 volts — 6K8, 6K8G, 6K8GT; 12.6 volts—12K8.

CONVERTER TRIODE HEPTODE: 6.3 volts—6J8G and 7J7.

CONVERTER OCTODE: 6.3 volts—7A8.

MIXER PENTAGRID: 6.3 volts —6L7 and 6L7G.

Electron Ray Tubes

SINGLE WITH REMOTE CUT-OFF TRIODE: 6.3 volts —6AB5/6N5 and 6U5/6G5.

SINGLE WITH SHARP CUT-OFF TRIODE: 2.5 volts—2E5; 6.3 volts—6E5.

TWIN WITHOUT TRIODE: 6.3 volts—6AD6G and 6AF6G.

Voltage Amplifiers

There are several subdivisions under this heading such as triodes. tetrode and pentode detectors, oscillators and diode detectors. Some of these special functions are often combined in the same tube envelope with a voltage amplifier.

TRIODES SINGLE UNITS WITH MEDIUM MU: 1.4 volts—1G4GT/G; 2 volts—1H4G and 30; 2.5 volts—27 and 56; 3 volts—485; 6.3 volts—6C5, 6C6GT/G, 6J5, 6J5GT/G, 6P5GT/G, 6L5G, 6AE5GT/G, 37 and 46; 12.6 volts —12J5GT.

TRIODE MEDIUM MU WITH R. F. PENTODE: 6.3 volts—6F7 and 6P7G.

TRIODE MEDIUM MU WITH POWER PENTODE: 6.3 volts — 6AD7G.

TRIODE MEDIUM MU WITH POWER PENTODE AND DIODE: 1.4 volts—1D8GT.

TRIODE MEDIUM MU WITH TWO DIODES—2 volts—1B5 and 1H6G; 2.5 volts—55; 6.3 volts—6R7, 6R7GT/G, 6SR7, 6ST7, 7C7, 7E6, 85 and 6V7G; 12.6 volts—12SR7.

TRIODE MEDIUM MU TWIN UNIT: 6.3 volts—6C8G, 6F8G, 6SN7GT; 12.6 volts—12AH7GT and 12SN7GT.

TRIODE MEDIUM MU WITH TWIN INPUT: 6.3 volts — 6AE7GT.

TRIODE MEDIUM MU WITH TWIN PLATES: 6.3 volts — 6AE6GT.

TRIODE HIGH MU SINGLE UNITS: 6.3 volts — 6F5, 6F5GT/G, 6SF5, 6SF5GT, 6K5GT/G and 7B4; 12.6 volts—12SF5, 12SF5GT and 12F5GT.

TRIODE HIGH MU WITH RF PENTODE: 12.6 volts—12B8GT; 25 volts—25B8GT.

TRIODE HIGH MU WITH DIODE AND RF PENTODE: 1.4 volts—3A8GT.

TRIODE HIGH MU WITH DIODE: 1.4 volts—1H5GT/G and 1LH4.

TRIODE HIGH MU WITH TWO DIODES: 2.5 volts—2A6; 6.3 volts — 6T7G, 7B6, 7C6, 6B6G, 6SK7, 6SK7GT/G, 6Q7, 6Q7G, 6Q7GT and 75; 12.6 volts — 12Q7GT, 12SQ7 and 12SQ7GT/G.

TRIODE HIGH MU TWIN UNIT: 6.3 volts—6SC7, 7F7 and 6SL7GT; 12.6 volts—12SC7 and 12SL7T.

TETRODES REMOTE CUT-OFF: 2 volts—1D5GT; 2.5 volts —35.

TETRODES SHARP CUT-OFF: 2 volts—32; 2.5 volts—24A; 6.3 volts—36.

PENTODE REMOTE CUT-OFF SINGLE UNIT: 1.4 volts—1T4 and 1P5GT; 2 volts — 34, 1D5GP and 1A4P; 2.5 volts—58; 6.3 volts—6K7, 6K7G, 6K7GT, 6AB7, 6SK7, 6SK7GT/, 6D6, 6E7, 6S7, 6S7G, 6SS7, 6U7G, 7A7, 7B7, 7H7, 39/44 and 78; 12.6 volts—12SK7, 12SK7GT/G, 12K7GT/G and 14A7/12B7.

PENTODE REMOTE CUT-OFF WITH TRIODE: 6.3 volts—6F7 and 6P7G; 12.6 volts — 12B8GT; 25 volts—25B8GT.

PENTODE REMOTE CUT-OFF WITH DIODE: 6.3 volts—6SF7, 12.6 volts—12SF7.

PENTODE REMOTE CUT-OFF WITH TWO DIODES: 6.3 volts—7E7.

PENTODE SEMI-REMOTE CUT-OFF SINGLE UNIT: 6.3 volts—6SG7; 12.6 volts—12SG7.

PENTODE SEMI-REMOTE CUT-OFF WITH TWO DIODES: 2.5 volts—2B7; 6.3 volts—6B8, 6B8G, 6B7 and 6B7S; 12.6 volts—12C8.

PENTODE SHARP CUT-OFF SINGLE UNIT: 1.4 volts—1N5GT/G, 1L4, 1LN5; 2 volts—1E5GP, 1B4P and 15; 2.5 volts—57; 6.3 volts—6J7, 6J7G, 6J7GT, 6C6, 6D7, 6W7G, 6SJ7, 6SJ7GT, 6SH7, 6AC7, 6AG5, 7C7, 7G7 and 77; 12.6 volts—12SH7, 12SJ7, 12SJ7GT and 12J7GT/G.

PENTODE SHARP CUT-OFF WITH TRIODE AND DIODE: 1.4 volts—3A8GT (also for 2.8 volt operation).

PENTODE SHARP CUT-OFF WITH DIODE: 1.4 volts—1S5.

PENTODE SHARP CUT-OFF WITH TWO DIODES: 1.4 volts—1F6 and 1F7G.

The foregoing classification of tubes is not a complete list since it does not include the very old tube types nor the very latest types. However, it is complete enough to give you a well rounded out knowledge of tube types. You should study this information in detail. It is not necessary to memorize tube types—what they are for and how they are used. This tube classification is one you should refer to often in the following lessons on tubes. It, together with a good manufacturer's tube manual, will provide all of the practical information you will need on radio tubes.

These questions are designed to test your knowledge of this lesson. Read them over first to see if you can answer them. If you feel confident that you can, then write out your answers, numbering them to correspond to the questions. If you are not confident that you can answer the questions, re-study the lesson one or more times before writing out your answers. Be sure to answer every question, for if you fail to answer a question, it will reduce your grade on this lesson. When all questions have been answered, mail them to us for grading.

QUESTIONS

No. 1. Two popular types of rectifier tubes are the HIGH VACUUM and MERCURY VAPOR. Compare the internal voltage drop of these two types of rectifier tubes.

No. 2. What is indicated when a bluish glow is noticed around the elements of a high vacuum rectifier tube?

No. 3. Is the current present in the filament circuit of an 80 rectifier tube A.C., D.C. or does it consist of both A.C. and D.C.?

No. 4. From a D.C. viewpoint, is the cathode of a rectifier tube the most negative or the most positive point in an A.C. power unit?

No. 5. With respect to the cold cathode type of rectifier, such as the OZ4, what is the main difference between it and such tubes as the 5Y3G and the 6X5?

No. 6. For what purpose is the synchronous rectifier used?

No. 7. Describe the R.M.A. tube pin numbering system with reference to the rotation of the hands of a clock.

No. 8. Give an example of the R.M.A. tube designation system and tell what each number or letter represents.

No. 9. What is meant by NOMINAL ratings in the tube designations of 7A6 and 14B8 type tubes?

No. 10. In such tubes as the 12SK7, what does the letter S denote?